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MULTI-LAYER LAMINATES AND METHOD OF MANUFACTURING HOLLOW ARTICLES THEREFROM

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12 Claims. (Cl. 29—157.3)

This is a continuation of prior U.S. application Serial No. 177,688, filed February 7, 1962, which in turn is a continuation-in-part of prior application Serial No. 719,688 filed March 6, 1958, now abandoned.

This invention relates to the manufacture of inflatable laminates suitable for producing hollow articles and products, and more specifically to an improved method wherein such a laminate is subjected to fluid under pressure to promote hollowing.

An object of this invention is the provision of a practical and reliable method for making hollow products from a novel laminate which contributes materially to ease and facility of manufacture of the hollow products in a shaping die.

Another object of the invention is that of providing a highly satisfactory method of pressure shaping laminated sheet, using fluid under pressure between the outside layers of the laminate, and which method introduces a very worthwhile mode of separation and working of the laminate in an external shaping die after the laminate has been easily brought into proper alignment with the die for the shaping operation to proceed.

Another object is the provision of a method of the character indicated in which the sheet components have reluctance against being separated from each other in the die except progressively by increments under the application of fluid pressure with the result that the entire area of the sheet material to be distended is not initially free and localized necking-in of the thickness of the distending sheet material adjacent to the restraining portions of the die is substantially diminished.

A further object of this invention is the provision of a method of the character indicated in which a bonded laminate used has its layers acted on in the die by the fluid pressure introduced between the layers while the laminate still maintains the bond between its members inside the die at the outset of the forming operation.

Another object is that of providing a direct and easily performed method for producing hollow products from bonded laminated sheet components, the method introducing a progressive breaking of the bond between portions of the laminate confined inside the die, which breaking is promoted by fluid pressure being introduced between the layers of the laminate.

Other objects and many of the attendant advantages of the invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIGURE 1 represents a sheet component of a laminate having demarked thereon a pressure fluid lead-in;

FIGURES 2 and 3 represent sheets having differently delineated bonding surfaces;

FIGURE 4 represents a sheet component having no lead-ins or delineated surfaces;

FIGURES 5 and 6 represent portions of sheets and are detail views of stop-weld patterns;

FIGURE 7 is a fragmentary sectional view taken through an expanded laminate to indicate outside configurations which may be achieved by inflating the laminate in a corresponding die;

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FIGURES 8, 9 and 10 respectively represent stages in the manufacture of a hollowed sheet product from a laminate;

FIGURE 11 is a fragmentary section taken through a shaping die and a laminate in it; and

FIGURES 12 and 13 represent different stages of inflating the laminate in one embodiment.

In the practice of the present invention laminates are forcefully subjected to the breaking of a bond between the layers by fluid introduced under pressure between the layers and acting against the strength of the bond in favor of separating the layers. A space giving access to the fluid to the region of bonding progressively enlarges under the pressure and the laminate actually is peeled apart between layers for the pressure causes the bond to break away progressively in the sense of peeling. The peeling is accomplished within limits so that the layers of the laminate remain bonded together beyond the zone of peeling and hollowing out that is desired. The fluid pressure also distends and stretches at least one of the outside layers of the laminate to enlarge the hollow space in the product being produced. By reason of the progressive breaking of the bond a highly satisfactory progression of stretching and working of the laminate by the force of the pressure is accomplished. The working stresses are better distributed and the thickness of the layer being acted upon remains more uniform throughout. The process is highly satisfactory for the manufacture of any of a variety of products having different shapes and sizes such as heat exchangers, plumbing assemblies, structural components, and so forth.

To the end of preventing peeling apart of the layers of the laminate beyond a certain desired limit by the fluid pressure introduced between the layers, a holding die applied externally to the laminate and having surfaces which restrict or block the spread of peeling preferably is used on the piece being formed. A die for present purposes in fact may include one or more dies or restraining members which restrict the separating effect of the fluid pressure on the laminated workpiece thus to accomplish a more definite and controlled contour body from the standpoint of shape and size of the outside of the piece. In this regard the die either limits the spread of peeling while the pressure of the fluid is being exerted between layers of the piece, or restricts distention of one or more outside layers which are being stretched and worked by the fluid or may accomplish both of these functions. One of the preferred procedures for producing a peel-bond in the laminate is that of providing between the layers which ultimately are to be separated by the force of the fluid, discontinuous bonded and unbonded innerfacial zones of the layers so that the bonded zones remain to be broken by the pressure and the unbonded zones stand as small zones of weakness between the layers. A very important aspect present in affording the bonded and unbonded zones is that the laminate lends itself to any of a number of positions of placement with respect to a contoured die face and any of those bonded and unbonded portions which fall under the die contour respond to the shaping force of the fluid pressure. A proper alignment accordingly is easily accomplished. The extent of the bonded and unbonded faces of the layers is controlled by such considerations as the overall area of laminate required for producing a specific product. Sometimes one layer of the laminate has its entire face peel-bonded to the face of the adjacent layer and reliance is placed upon the clamping effect of a die to restrain the laminate against separation outside the reaches of the die cavity. In certain other instances, the marginal edges of the laminate are firmly bonded and inside this margin there is an area of peel-bonding, as for example,